SHOCK-INDUCED VOLATILE LOSS FROM A CARBONACEOUS CHONDRITE AND PLANETARY ACCRETION, Benjamin Frisch and Thomas J. Ahrens, Seismological Laboratory, California Institute of Technology, Pasadena, California 91125.

Shock wave recovery experiments on which samples of Murchison meteorite were impact in air at 50 μTorr have been undertaken to test whether impact induced devolatilization during accretion could yield a planetary atmosphere. Several authors [1,2,3] have suggested that a primitive atmosphere is produced during the accretion of planets, rather than it being a later, secondary feature. Recent experiments on serpentine, [4,5] calcite, [6] and dolomite show that disproportionation of minerals containing structural volatiles, H_2O and CO_2 - can occur at impact velocities as low as 600 m/sec, yielding ~5 GPa in silicates and complete vaporization is predicted to occur at impact speeds of 2 to 4 km/sec or pressures of 70 to 100 GPa, depending on the mineral. Murchison meteorite was chosen as a planetesimal analog. Prepared samples (density 2.85 g/cm^3) of Murchison meteorite were impacted by steel flyer plates (see table) in atmospheric humidity and CO_2 partial pressure. The shocked material was immediately removed to a thermoanalyzer and a moisture evolution analyzer, to measure post shock volatile content. These data are compared to an unshocked reference sample of Murchison, and to other published studies of volatiles in carbonaceous chondrites. [7,8]

The recovered shocked material of shot #1 lost 89.1%, by weight, of its water (releasable at temperatures greater than 100° C) and 38.0% by weight of all volatiles. This compares to a loss of 48% of the water from serpentine, at similar shock pressures. Shot #2 lost 39.8% of its total volatiles at half the pressure of shot #1, this is unexplained - perhaps the initial volatile content in the Murchison samples were different. A shift from OH^- speciation in hydrous phases, to surficial H_2O speciation was prominent. It is likely that carbon and sulfur species were also lost, but not as efficiently as water. The surface-bound volatiles are available for vaporization upon later impact.

Murchison loses over a third of its volatile content at impact velocities as low as 1.4 km/s. The present experiments, in conjunction with previous work, supports the hypothesis that a primary atmosphere could be formed by impact processes. Initial results suggest that such an atmosphere would be dominated by H_2O if the accreting materials are similar to C2M carbonaceous chondrites and more water is lost at lower shock pressures than predicted for pure serpentine.

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Table 1

Shot #	Sample mass mg.	Steel projectile velocity km/s	Pressure in container GPa	Shock-induced volatile loss wt. %	Shock-induced water loss wt. % of water	Water loss in serpentine at this pressure wt. %*
1	19.4	2.5	34	38.0	89.1	48
2	19.3	1.4	17.3	39.8	-	~0

*serpentine data from Ref. (3).

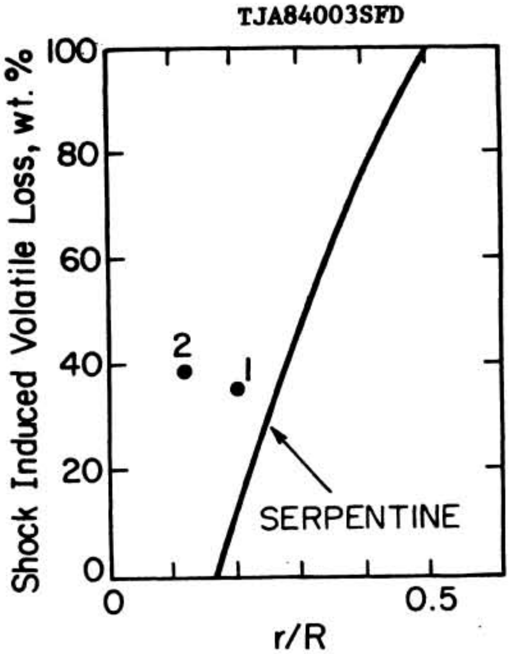

Figure 1. Shock-induced water loss for Murchison (1,2) compared to shock-induced water loss in serpentine as a function of relative size, r/R, of the accreting earth. Serpentine data from Ref. (3).